

**Journal of Endodontics, 1995, Vol. 21**

**JULY**

**Col. Schindler, Chairman Of Endodontics  
59th MDW Dental Directorate  
Lackland AFB, TX**

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## Physical and chemical properties of a new root-end filling material

*Torabinejad M, Hong CU, McDonald F, Pitt Ford TR. Physical and chemical properties of a new root-end filling material. J Endodon 1995;21:349-53.*

**PURPOSE:** To determine the chemical composition, pH, and radiopacity of MTA, and to compare the setting time, compressive strength, and solubility of MTA with amalgam, Super-EBA, and IRM.

**M&M:** A KVEX Delta 4460 X-ray Energy dispersive spectrometer (I have one of those!) in conjunction with SEM was used to study the chemical composition of MTA. A pH meter was used to evaluate the pH of MTA as it set. The radiopacity of MTA was determined according to the method described by the ISO. Setting times of the four materials were determined and compared, and consisted of the duration of time that elapsed from start of mixing to when an indenter needle failed to make an indentation in the material. Compressive strength were measured with an Instron machine. Solubility was determined by a modified method of the ADA specification #30.

**RESULTS:** All MTA was composed of calcium oxide and calcium phosphate, the former appearing as discrete crystals, and the latter as an amorphous, granular substance. After mixing, the pH of MTA was 10.2, rising to 12.5 after 3 h. The mean radiopacity of MTA was 7.17 mm of equivalent thickness of aluminum. The mean setting times for the 4 materials were: amalgam, 4 min; Super-EBA, 9 min; IRM, 6 min; MTA, 2 h 45 min. Amalgam had the highest compressive strength, with MTA the lowest of the 4 materials after 24 h. MTA showed no appreciable solubility over 21 days.

**DISCUSSION:** Calcium and phosphorus are the main ions present in MTA powder; since these are also the principle ions found in dental hard tissue, MTA may prove to be biocompatible when in contact with living tissue. Induction of a hard tissue barrier may occur when MTA is used as a root-end filling material. In previous experiments, MTA has shown less dye and bacterial leakage than other materials. This may be a function of its long setting time reducing the amount of shrinkage. From the study, amalgam, Super-EBA, and MTA did not show signs of solubility in water.

**C&C:** MTA appears to have adequate physical properties for use as a root-end filling material.

July 1995

Michael Hall

## **A comparison of three different root canal sealers when used to obturate a moisture-contaminated root canal system**

*Horning TG, Kessler JR. A comparison of three different root canal sealers when used to obturate a moisture-contaminated root canal system. J Endodon 1995;21:354-7.*

**PURPOSE:** To determine the quality of the apical seal obtained by the obturation of moisture-contaminated canals with the lateral condensation of gutta-percha (GP) and three different classes of endodontic sealers: a zinc oxide-eugenol (ZOE) type, a calcium hydroxide (CaOH) type, and a glass ionomer cement (GIC).

**M&M:** 132 extracted, single-rooted teeth were endodontically prepared in a standardized fashion, using coronal flaring and a step-back technique. 12 teeth served as controls. Six groups of 20 were apically injected with saline and immediately obturated with a #40 master GP cone and one of 3 sealers: groups 1 and 4-ZOE (Procosol); groups 2 and 5-CaOH (Sealapex); and groups 3 and 6-GIC (Ketac-Endo). All specimens were Cavit-sealed and allowed to set for 7 d. Next, groups 1,2, and 3 were immersed in ink and a vacuum was applied. Following clearing, the quantity of dye penetration into the apical space was measured. Groups 4,5, and 6 were stored in saline for 9 mo prior to identical dye measurement procedures.

**RESULTS:** The 7 d specimens showed that the apical seal produced by obturation with Procosol was sig better than both Sealapex and Ketac-Endo. Also, Sealapex was sig better at sealing than Ketac-Endo. Dye penetration in the samples after 9 mo exposure to liquid showed essentially no difference in the amount of leakage as compared with the samples tested immediately after set of the material.

**C&C:** Apparently, a ZOE-based sealer (such as Procosol) will provide a superior seal initially when used in a moisture-contaminated canal, as compared with Sealapex or Ketac-Endo. The most predictable results are obtained if the root canal system is as dry as possible before obturation. Moisture accelerates the setting reaction of CaOH, possibly preventing complete wetting of the GP and dentin with the sealer. Moisture dissolves away matrix-forming cations in GIC's, thereby inhibiting critical aluminum polysalt formation and proper set of the material. The authors speculated that the deleterious effects of moisture occur during the initial placement and setting reaction of the sealers tested.

**July 1995**

**Christopher F. Bates**

## An ultrastructural study of debris retention by endodontic reamers

*Dautel-Morazin A, Vulcain J-M, Guigand M, Bonnaure-Mallet M. An ultrastructural study of debris retention by endodontic reamers. J Endodon 1995;21:358-61.*

**PURPOSE:** To determine the structure of the organo-mineral coating retained by endo reamers.

**M&M:** 15 human extracted molars were studied. Crowns were separated, pulp tissue removed, and the teeth divided into 3 groups: *group 1*, instrumentation without irrigation; *group 2*, instrumentation with irrigation using saline; *group 3*, instrumentation with irrigation using Dakin's solution. Instrumentation was for a 1-min period using Rispi reamers mounted on a counterangle Giromatic Micromega 6/15 AE. Secondary electron imaging (SEI) was used to evaluate the amount of material retained on the surfaces of the reamers and backscattered electron imaging (BEI) was used to give information about the organo-mineral composition of the smear layer adhering to the reamers.

**RESULTS:** SEI of group 1 showed the working surfaces of the reamers covered by a thick layer of heterogeneous organo-mineral material with isolated tubular structures. SEI of groups 2 and 3 showed very little debris on reamers with some tubular material corresponding to dentin fragments trapped behind reamer barbs. BEI of group 1 showed that the material retained on reamers at the beginning of the instrumentation period was more organic and the material at the end of the instrumentation period was highly mineralized. BEI of group 2 showed the material adhering to reamers was predominantly organic. BEI of group 3 was similar to that of group 1.

**DISCUSSION:** The SEI observations demonstrate clearly the need for irrigation during instrumentation, as group 1 reamers accumulated a great deal of adherent material. High magnification of material on Rispi reamers showed that use without irrigation creates a smear layer by abrasion of the canal walls and not by sectioning of dentin since the adherent material had no defined structure, ie no tubules. In contrast, use of an irrigant improved the use of the reamers, which did result in dentin sections being removed from canal walls.

July 1995

Michael Hall

## A three-dimensional finite-element stress analysis of an endodontically prepared maxillary central incisor

*Ricks-Williamson LJ, Fotos PG, Goel VK, Spivey JD, Rivera EM, Khera SC. A three-dimensional finite-element stress analysis of an endodontically prepared maxillary central incisor. J Endodon 1995;21:362-7.*

**PURPOSE:** To derive mathematical, 3-D models of an intact and endodontically prepared central incisor, and to use these models to measure stress distributions following simulated biomechanical preparation and application of lateral condensation (LC) and vertical condensation (VC) loads.

**M&M:** A max central incisor was embedded in resin, and sectioned into 0.25 mm slices which were photographed and digitized. Computer imaging programs were used to create two mathematical 3-D models of the incisor, from the CEJ to the root apex. These were designed to simulate ideal canal preparation and overpreparation, ie apical preparation sizes of #40 and #100, with respective orifice sizes of 1.6 mm and 3.45 mm. A finite elemental method was used to simulate the forces during simulated obturation, and determine stress distributions within the tooth, for static vertical and lateral loads of 3 kg.

**RESULTS:** The highest stresses were concentrated around the coronal and middle thirds of the root in each model. Combined tensile and compressive stresses occurred throughout static loading. The VC model with the overprepared apical diameter (1.0 mm) produced the highest tensile stresses. The VC model with the ideal apical diameter (0.40 mm) produced the highest compressive stresses. In ~~the~~ *ideal preparations*, the maximum tensile stress using VC occurred along the external lingual surface. With LC forces, the highest tensile element was located along the internal lingual surface. In ~~the~~ *overprepared model*, VC exhibited maximum stresses along an external facial element.

**C&C:** Very technical reading, yet the engineering complexity is a great advance from the previous 2-D models, which were an oversimplification and did not accurately duplicate a natural tooth. In each biomechanically prepared model here, VC produced higher stresses than LC, probably due to the larger surface area over which VC occurs. Also, larger preparations lead to higher stresses when VC was applied. LC produced higher stresses in the smaller preparations than in the larger preparations, however. Therefore, larger diameter preps received the greatest stresses when VC was used and the least when LC was used. This study suggests that the most likely location of root fracture during condensation would be between the middle and coronal thirds. Finally, when a canal preparation is beyond ideal size, perhaps LC would best limit the force distribution throughout the root and decrease the chance of root fracture.

July 1995

Christopher F. Bates

## Evaluation of root thickness in curved canals after flaring

*Isom TL, Marshall JG, Baumgartner JC. Evaluation of root thickness in curved canals after flaring. J Endodon 1995;21:368-71.*

**PURPOSE:** To compare the root thickness before and after flaring with Gates Glidden burs and the M-Series Canal Openers in the mesial canals of lower molars.

**M&M:** Twenty-six lower 1st and 2nd molars were studied. The muffle system introduced by Bramante and Berbert, 1974, and modified by McCann et al., 1990, was used to evaluate root thickness between the canal and the closest point of the furcation before and after the use of the rotary instruments. After instrumentation to a #25 file, the teeth were mounted in the muffle with the roots placed in casting resin; the teeth were then sectioned horizontally, the 1st cut just below the furcation, and 2 more sections at 2-mm intervals apical to the first. Measurements before and after flaring were made from the mesial canals to the thinnest portion of the root to the furcation. Four methods of flaring were used: *Gates S*, *Gates #2* and *#3* with a straight up-and-down motion; *Gates A*, *Gates #2* and *#3* with an anticurvature motion; *Canal S*, *#30* to *#70* Canal Openers used straight up-and-down; *Canal A*, *#30* to *#70* Canal Openers used in an anticurvature motion. The post-flaring measurement was subtracted from the pre-flaring measurement to give the amount of dentin removed during flaring.

**RESULTS:** The *Gates S* method removed significantly more dentin than the *Canal S* or *A* methods at the furcation level; at the level 2 mm apical to the furcation, the *Gates A* method removed significantly more dentin than any of the other methods; often, little or no dentin was removed 4 mm apical to the furcation.

**C&C:** *Gates* burs used in a straight up-and-down motion removed more dentin at the furcation level than Canal Openers used either straight up-and-down or in an anticurvature motion. Also, *Gates* used in an anticurvature motion removed more dentin at a level 2 mm apical to the furcation than any other method tested. Therefore, this study indicates that prudence dictates using *Gates* in an anticurvature motion only to the level of the furcation, and then in an up-and-down motion deeper in the canal.

July 1995

Michael Hall

## Effect of traumatic occlusion on periapical lesions in rats

*Kumazawa M, Kohsaka T, Yamasaki M, Nakamura H, Kameyama Y. Effect of traumatic occlusion on periapical lesions in rats. J Endodon 1995;21:372-5.*

**PURPOSE:** To investigate histologically and histometrically the effect of experimental unilateral traumatic occlusion on the pulpal and periapical tissues after pulpal exposure in rats.

**M&M:** 80 Wistar rats were divided into 4 groups: (A) no tx; (B) pulpal exposure of max left 1st molar; (C) a resin plate was cemented onto the occlusal surfaces of the max left molars; (D) received both pulpal exposure and the resin plate. At 1, 2, 4, and 6 wk after pulpal exposure or plate insertion, the rats were killed and their blocked jaws were studied by light microscopy. The inflammation, abscess, and alveolar bone resorption in the pulp and periapical tissues were observed. Measurements were made of the periodontal ligament on 5 serial sections of each mandible.

**RESULTS:** *Histologic* - group A-no changes; B-at 1-2 wk, remarkable pulpitis was observed; at 4 and 6 wk, the entire pulpal tissue was necrotic and periapical tissues exhibited inflammation, abscess and bone resorption; C-at 1, 2, and 4 wks compression of the PDL and alveolar bone resorption were found; these changes were in early stages of repair at 6 wk. No histological changes occurred in the pulpal tissue; D-at 1 and 2 wk, compression of the PDL and inflammation were < in group B, and no abscess or bone resorption was found. At 6 wk, the inflammation was still less than that in group B. *Histometrical* - vertical and horizontal lengths, as well as the area of the PDL in group C was sig smaller than those measurements in group A. Lesions in the periapical PDL at 1, 2, and 4 wk in group D were significantly smaller than those in group B.

**C&C:** This study showed a strong histologic correlation between the enlargement of a periapical lesion and traumatic occlusion. It suggests that traumatic occlusion delayed the enlargement of periapical lesions in rats. One possible explanation is that compression of PDL in the periapical area results in delay of spread of inflammation.

July 1995

Christopher F. Bates

## Microleakage of posts used to restore endodontically treated teeth

*Fogel HM. Microleakage of posts used to restore endodontically treated teeth. J Endodon 1995;21:376-9.*

**PURPOSE:** To apply a fluid filtration system to measure the microleakage of various post systems.

**M&M:** 80 extracted maxillary anterior teeth were used. The crowns were removed at the CEJ, the canals prepared to a size #25 K-file, and the coronal portions flared with Gates #2 and #3. Post spaces were prepared to a depth of 7 mm and the apices removed, leaving a final root length of 10 mm. The teeth were divided into 8 groups of 10. There were two positive control groups, one with the canals left empty, and one with #4 Para Posts inserted without cement. There were 5 experimental groups in which posts were cemented with zinc phosphate, polycarboxylate cement, a composite resin, composite resin with bonding agent, and composite resin with dentin conditioner and bonding agent. The last group was a negative control with Para Posts cemented with cyanoacrylate. The apical root portions were enlarged, 18-gauge SS tubing was attached, and the tubing connected to a filtration system as described by Derksen et al., 1986. Nitrogen moved isotonic saline under pressure from a reservoir through a micropipette into the apical end of the teeth. Microleakage was measured by movement of an air bubble in the micropipette.

**RESULTS:** Positive controls leaked significantly more than the experimental groups. Due to large variances within the experimental groups, there were no significant differences between them; however, log transformation created more homogeneous variances and thus created significant differences in some groups: the groups with resin and bonding agent and resin, conditioner, and bonding agent showed significantly less microleakage than the other experimental groups. Only 10% of the experimental samples showed zero microleakage.

**DISCUSSION:** None of the materials tested could predictably and consistently achieve a fluid tight seal. According to the criteria of Wu et al., 1993, none of the post systems studied could be considered "bacteria-tight." The amount of fluid filtration measured in vitro has not been correlated with clinical failure, however.

July 1995

Michael Hall



## **Incidence and position of the canal isthmus. Part 1. Mesibuccal root of the maxillary first molar**

*Weller RN, Niemczyk SP, Kim S. Incidence and position of the canal isthmus. Part 1. Mesibuccal root of the maxillary first molar. J Endodon 1995;21:380-3.*

**PURPOSE:** To determine the incidence and location of the canal isthmus in the MB root of the maxillary first molar.

**M&M:** 50 max left and right first molars were resected of their MB roots. Each root was imbedded in clear resin and transversely sectioned, starting at the apex, at 1-mm increments to a level 6 mm from the apex. The arranged sections were stained with dye and examined at  $\times 32$  mag. Two investigators determined the number of root canals present and the presence or absence of an isthmus. If present, an isthmus was classified as complete or partial. Canal configurations were classified according to Weine.

**RESULTS:** One root canal was found in 40% of the roots, and two canals were present 60% of the time. All type II canals (2 $\rightarrow$  1) converged within 2-4 mm of the apex. No sections had  $> 2$  main root canals. Of those with 2 canals, the incidence of an isthmus, either complete or partial, was highest in the 3-5 mm sections. The 4-mm sections contained a complete or partial isthmus 100% of the time.

**C&C:** In this article, the concept of a partial isthmus was presented; ie, an incomplete communication with one or more patent openings, between the two main canals. The frequent finding of a partial isthmus accounts for the very high reported total isthmus frequency. Any openings on the resected root surface could contain microbes or necrotic tissue, or act as a portal of exit for an uninstrumented or unfilled part of the root canal system. Failure to deal with this isthmus may explain why some posterior teeth do not heal completely following endodontic surgery. Whenever any part of the MB root is resected and two main canals are located, assume an isthmus exists. The area between the two canals should always be prepared and sealed with a retrofill.

**July 1995**

**Christopher F. Bates**

## Evaluation of success and failure after endodontic therapy using a glass ionomer cement sealer

*Friedman S, Löst C, Zarrabian M, Trope M. Evaluation of success and failure after endodontic therapy using a glass ionomer cement sealer. J Endodon 1995;21:384-90.*

**PURPOSE:** To assess the treatment results after endodontic therapy using Ketac-Endo sealer, and to relate the results to various preoperative, intraoperative, and postoperative clinical factors.

**M&M:** 486 teeth in 401 patients were endodontically treated by three clinicians in Germany, Israel, and the United States. All teeth were prepared using a standardized protocol. Ketac-Endo was used with a single standardized gutta-percha cone prefitted to the working length and seated into the canal without accessory cones. In 320 teeth no condensation was used; in 58 teeth gutta-percha was laterally condensed. Patients were recalled six to 18 months after treatment and were judged by the following criteria: *success* - absence of clinical signs, symptoms, or periapical radiolucency; slight tenderness to percussion permitted; *incomplete healing* - absence of clinical signs or symptoms, including tenderness to percussion, and a decreased size of the periapical lesion; *failure* - presence of pain, swelling, or a sinus tract, regardless of radiographic appearance; decreased size of the periapical lesion and tenderness to percussion; or development of a periapical lesion or no change in size of the lesion.

**RESULTS:** 378 teeth (78%) were able to be followed up at recall. 296 were classified as success (78.3%), 59 teeth as incomplete healing (15.6%), and 23 as failures (6.1%).

**DISCUSSION:** This prospective study used strict assessment criteria to judge cases as success or failure, thus it had a lower success percentage than some studies have shown. Some trends that were noticed included: teeth with single canals showed a higher success rate than teeth with multiple canals; success rate was lower following retreatment than initial treatment; the failure rate in teeth with infected canals and resulting periapical lesions was almost 3 times higher than in teeth without lesions; treatment results were significantly poorer in symptomatic teeth than in asymptomatic teeth; treatment in a single session resulted in a 10% higher success rate than multiple session treatment; treatment results did not differ significantly for underextended, adequate, or overextended fillings; complications in therapy such as sealer extrusion decreased the success rate; type of restoration and presence or absence of a post did not affect the success rate. Overall, the results supported the use of Ketac-Endo as a root canal sealer in endodontic therapy.

July 1995

Michael Hall

## Evaluation of the effect of delayed management of traumatized permanent teeth

*Al-Nazhan S, Andreasen JO, Al-Bawardi S, Al-Rouq S. Evaluation of the effect of delayed management of traumatized permanent teeth. J Endodon 1995;21:391-3.*

**PURPOSE:** To evaluate complications which might arise from delayed management of traumatized permanent teeth.

**M&M:** 114 patients seeking treatment of traumatized anterior teeth (at a Saudi Arabian dental school) were studied. The reasons for seeking tx and a history of the traumatic event were recorded. All injured teeth were examined clinically for discoloration of the crown, tenderness to percussion, and reaction to cold and EPT. Radiographs were also evaluated for the presence of root resorption and/or bone loss.

**RESULTS:** The patient sample was 47% male and 53% female. Falls accounted for 54% of the injuries, whereas contact sport (4%), fights (18%), and other causes (24%) were responsible for the rest. The location of traumatized teeth was found to be max centrals-75%, max laterals-11%, man centrals-7.5%, man laterals-4%, and others-2.5%. Most patients sustained their injuries between the ages of 6-8, and most delayed tx over 1 mo. Esthetic reasons for seeking tx were as frequent as symptoms.

<i>Type of Injury</i>	<i>Pulp Necrosis (%)</i>	<i>Pulp Calcification (%)</i>
<b>Intact crown</b>	38.8	10.2
<b>Crown fracture</b>		
<b>Enamel only</b>	10	0
<b>Enamel and dentin</b>	53.4	0
<b>Pulp exposure</b>	100	0
<b>Crown-root fracture</b>	100	0
<b>Horizontal Root fracture</b>	43.7	0

**C&C:** Late management of impact dental injuries leads to a high frequency of pulp necrosis. The high frequency of pulpal necrosis following enamel and dentin fracture in this investigation could be due to bacterial invasion through open dentinal tubules. Parents need more education with regard to bringing in children immediately following any dental trauma. Furthermore, all traumatized, initially nontreated teeth should be diagnostically evaluated for pulpal and periodontal complications.

**July 1995**

**Christopher F. Bates**

## **Solution for the isolation of the working field in a difficult case of root canal therapy**

*Iglesias AM, Urrutia C. Solution for the isolation of the working field in a difficult case of root canal therapy. J Endodon 1995;21:394-5.*

**PURPOSE:** To present a technique for the isolation of a posterior tooth with large, proximal cervical caries.

**DISCUSSION:** The clinical procedure, using a modified rubber dam technique as described by Croll, 1985, involved removing a defective DO amalgam on a lower right second molar, along with carious tooth structure and the coronal pulp. The chamber was covered with a PCP cotton pellet, eugenol-free cement, and dental stopping, and a direct Duralay resin temporary was made. The inlay resin was trimmed and cemented with Temp-Bond. The tooth could then be isolated in a standard manner for RCT.

**July 1995**

**Michael Hall**